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Analysis of Convair 990 Rejected-Takeoff Accident With Emphasis on Decision Making, Training, and Procedures

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ANALYSIS OF CONVAIR 990 REJECTED-TAKEOFF ACCIDENT WITH EMPHASIS ON
DECISION MAKING, TRAINING, AND PROCEDURES

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INTRODUCTION

This paper analyzes a NASA Convair 990 (CV-990) accident with emphasis on rejected-takeoff (RTO) decision making, training, procedures, and accident statistics. Although the NASA Aircraft Accident Investigation Board did not fault the crew's action, it was somewhat perplexed that an aircraft could be destroyed as a result of blown tires during the takeoff roll. To provide a better understanding of tire failure RTO's, the Board obtained accident reports, Federal Aviation Administration (FAA) studies, and other pertinent information related to the elements of this accident. This material enhanced the analysis process and convinced the Accident Board that high-speed RTO's in transport aircraft should be given more emphasis during pilot training. Pilots should be made aware of various RTO situations and statistics with emphasis on failed-tire RTO's. This background information could enhance the split-second decision-making process that is required prior to initiating an RTO.

ACCIDENT SYNOPSIS

On July 17, 1985, at 1810 P.d.t.,¹ NASA 712, a Convair 990 aircraft, was destroyed by fire at March Air Force Base, California. The fire started during the intentional extended rollout after the pilot rejected the takeoff on runway 32 (13,300 feet long). The rejected takeoff was initiated during the takeoff roll because of blown tires on the right main landing gear. During the extended rollout, fragments of either the blown tires or the wheel/brake assemblies penetrated a right-wing fuel tank forward of the right main landing gear. Leaking fuel ignited while the aircraft was rolling, and fire engulfed the right wing and fuselage after the aircraft was stopped on the runway. The 4-man flightcrew and the 15 scientists and technicians seated in the cabin evacuated the aircraft without serious injury. The fire was not extinguished by crash/fire/rescue efforts and the aircraft was destroyed.

The NASA Aircraft Accident Investigation Board determined that the probable cause of the accident was the nearly simultaneous failure of the two front tires on the right main landing gear at a critical time during the takeoff roll. These failures resulted in the pilot's decision to reject the takeoff. Contributing to the severity of the accident was an intense fire fed by leakage from the puncture of a right-wing fuel tank forward of the right main gear; the puncture occurred during the intentional extended rollout of the aircraft.

¹All times are Pacific daylight savings time based on the 24-hour clock.

HISTORY OF THE FLIGHT

The aircraft was dispatched at a ramp weight of 232,500 lb (240,000 lb ramp weight limit). On the basis of the atmospheric conditions at the time of takeoff, the crew had calculated a decision speed V_1 of 151 knots, a rotation speed V_R of 154 knots, and an initial climb speed V_2 of 167 knots. The balanced-field length was calculated to be 10,500 feet, 2,800 feet less than the actual length of March Air Force Base runway 32 (13,300 feet).

The flightcrew stated that everything was normal in the cockpit during the first part of the takeoff roll. However, the occupants of the cabin and several witnesses outside the aircraft noted abnormalities. A technician, watching a television monitor linked to a camera focused on tire 3 (fig. 1), noticed deformation of the tire early in the takeoff roll before the tire blew out. Another technician occupying a right-side cabin seat aft of the wing had a fleeting perception of a "black object flying over the wing." An outside witness made a similar comment. Other witnesses, who were positioned about 2 miles from the aircraft, noticed white smoke coming from the aircraft underside early in the takeoff roll. There was no indication of these abnormalities in the cockpit, nor did the cabin occupants relay their observations to the flightcrew.

As the aircraft accelerated, the pilot heard two rapid explosive bangs and immediately felt a "kind of quivering of the aircraft." These sounds were recorded on the cockpit voice recorder (CVR). The flightcrew recognized the sound as a blown tire. The pilot, in the right seat, recalled seeing the air-speed indicator pass 140 knots. The flight engineer recalled "seeing a speed of 135 to 140 knots." Several technicians in the cabin were in the habit of monitoring and cross-checking inertial ground speed readouts, and they recalled a reading of 144 knots at the time of the explosions. The flight data recorder (FDR) indicated that 143 knots was the maximum speed attained. The CVR indicated that the aircraft commander occupying the right seat called out "abort," almost simultaneously with the flight engineer's call of "blown tire." A rejected takeoff (RTO) was begun. The pilot closed the power levers, deployed the spoilers, and selected reverse thrust on all four engines. Being aware that the runway at March Air Force Base was 13,300 feet long (2,800 feet longer than the calculated balanced-field length), the pilot informed the crew that he was going to "stay off the brakes." In later interviews, the pilot stated that he used light braking during the rollout. During the first phase of the RTO, the aircraft swerved slightly to the right, and the pilot acted to bring the aircraft back toward the runway centerline.

Nine seconds after the first explosions, another bang was heard by the flightcrew and recorded on the CVR. The flight engineer stated "blew another one." Five seconds later the CVR recorded the application of reverse thrust, 14 seconds after the first tire blew out. As reverse thrust was being applied, another bang was recorded on the CVR but was not noticed by the flightcrew. During the rollout the pilot stated that he was not sure on which side the tires had blown but, based on the sound, thought that they were on the left side.

The pilot reduced reverse thrust on all engines after the flight engineer called "3000" (meaning 3000 ft remaining), as recorded on the CVR. Approaching the end of the runway and without knowledge of a fire, the pilot started a

right turn toward the last taxiway in an attempt to clear the runway. After hearing a call of "fire on the right side" from the technicians in the cabin area, the pilot immediately brought the aircraft to a stop at about 12,700 feet. The engines were shut down by using the emergency shutdown handles. The aircraft commander released his seatbelt and shoulder harness and opened the right cockpit window to assess the situation. He noted fire near the right main landing gear and raw fuel pouring out of the wing in front of that gear and immediately ordered the flightcrew to evacuate the aircraft.

ACCIDENT SEQUENCE ANALYSIS

To assist the Accident Board in analyzing the sequence of the aircraft accident events, a runway event reconstruction was diagrammed (fig. 2). This was accomplished by identifying the debris and its location on the runway, along with marks made on the runway surface primarily by the tire and wheel assemblies of the right main landing gear. From this and other factual data, the following accident sequence analysis was made.

As the aircraft taxied onto runway 32, it left a distinctive white track (fig. 3). The aircraft tires scrubbed black jet engine exhaust deposits off the concrete runway surface during the turn onto the runway. These white tire marks faded away as the aircraft entered the moderate-to-heavy rubber-contaminated area near the runway centerline at about 700 feet.² The width of the individual tire tread was uniform, showing no evidence of lost inflation pressure or other tire abnormality. Light or even moderate brake drag probably would not be detected on the runway or taxiway surface, but subsequent heat effects would have occurred in the tire body. The first tire rubber shards were found at about 1,400 feet on the right side of the centerline near the arresting gear cable. At 2,200 feet and about 11 feet right of the centerline, fresh squiggly rubber marks were found on the rubber-coated concrete surface in line with the estimated position of tires 3 and 7 (fig. 1). These wavy intermittent rubber marks, visible for about 400 feet (fig. 4), were later associated with tire 3 by tread debris found nearby. All of the tire fragments collected on the runway between 1,300 and 4,000 feet were later identified with tire 3. The tire 3 retread cap (fig. 5), most of which was recovered, showed no heat effects. Inspection of the wheel bearings on the right main landing gear, with particular emphasis on bearings 3 and 4, revealed no abnormalities. An inspection of the brakes, although not conclusive because of fire damage, showed no evidence of dragging. Therefore it was concluded that the main gear tires were properly inflated and that the brake systems were normal during the initial takeoff acceleration roll.

Rubber marks were found on the runway surface at 4,125 and 4,138 feet, indicating where tire 4 and then tire 3 blew out. The CV-990 aircraft has dual nose wheels and eight main gear tires mounted on two four-wheel trucks. Each main gear truck has two axles, one fore and one aft of the landing gear strut. The design allows vertical but not lateral pivoting of the truck. Consequently, a failure of one of the tires results in that load being shifted to the remaining tire on the same axle.

²All references to runway 32 distances are in feet starting at the approach/takeoff end (0 ft) and progressing to the departure end (13,300 ft).

The analysis of tire and wheel marks on the runway indicated that the failure sequence began when the tread from the tire 3 started coming apart at about 1,400 feet. The failing tire 3 caused tire 4 (both on the same axle) to run in an overloaded condition. This continued until the 4,125-foot mark, when tire 4 blew, followed 0.05 second later by the blowout of the tire 3 carcass at 4,138 feet. The postaccident examination of the tire fragments indicated that extreme heat had built up in tire 4, contributing to its failure. Fragments of tires 3 and 4 were scattered over a large portion of the runway surface between 4,000 and 5,200 feet. The drag resulting from the tire failures caused the aircraft to swerve slightly to the right. Marks on the runway indicated that the swerve began within 300 feet (less than 2 seconds) of the first two tire blowouts. There were no visible indications of left main gear wheel braking to correct for this swerve and, in fact, the pilot stated that he was "going to stay off the brakes." The actions taken by the pilot, after the first tire blowouts, were to close the throttles (the CVR indicated that the throttles were closed within 4 seconds of these blowouts), to deploy the spoilers, and to correct for a slight right swerve. There was no runway evidence of wheel braking from either the fully operational left main gear or the failing right main gear during the entire rollout.

With the failure of tires 3 and 4 on the right truck, visible score marks (fig. 6), starting at about 4,175 feet, showed where the number 3 and 4 frangible aluminum wheels contacted the runway. The right side of the aircraft was now supported by tires 7 and 8 and wheel rims 3 and 4. The aircraft began riding intermittently on wheel rims 3 and 4 from the 4,175-foot point, since most of the rubber of tires 3 and 4 (except for the bead bundles) quickly abraded. Wheel fragments from wheels 3 and 4 were found on the runway starting at about 5,600 feet, the point at which the rims started breaking up, scattering fragments in all directions. A fragment from wheel 4 is shown in figure 7. These fragments may have contributed to the failure of the two rear tires. Rubber marks on the runway surface at 6,190 feet indicated where tire 8 blew out. From CVR information this occurred 9 seconds after tire 4 blew out. The flightcrew perceived this as the second tire failure. Scuff marks on the runway surface at 7,300 feet (fig. 8) indicated where tire 7 blew out, and the sound was recorded on the CVR. However, the flightcrew stated that they did not hear the blowout as it was masked by the sounds of engine spoolup as reverse thrust was being applied 12 seconds after the "abort" callout. A large number of tire rubber and wheel fragments were found scattered over the runway from 7,100 to 8,400 feet (fig. 9).

From witness testimony it is suspected that the wing was punctured after failure of the number 3 and 4 rim and wheel assemblies, somewhere between 6,000 and 7,000 feet from the takeoff end of the runway. Wheel scuff marks on the runway surface at 8,000 feet indicated that wheels 3 and 4 were worn down to the hub (wide marks) but that wheels 7 and 8 were still rolling on the rims (two narrow marks for each wheel). The scuffing on the runway of the tire remnants and bead bundles and the failure of tires 7 and 8 probably caused an almost continuous trail of white smoke to be emitted from the underside of the aircraft. However, it was not until after 7,000 feet that outside witnesses described intermittent flashes of fire around the right main gear. Inside witnesses saw flames coming from under the right wing flaps at 10,000 feet and passed this information to the flightcrew. The first evidence of fire on the runway - scorched, discolored concrete surface - was at 11,950 feet. The marks were in line with the tracks of the right main gear wheels. The scorched surface marks persisted down the runway to the aircraft stop point at 12,660 feet

(figs. 10 and 11). The aircraft was immediately evacuated after it was brought to a stop. Shortly thereafter the aircraft was engulfed in flames (figs. 12 and 13). The aircraft wreckage on the runway was photographed from a helicopter (fig. 14) and at various ground locations (figs. 15 and 16).

ADDITIONAL INFORMATION

After studying the runway event sequence and to help the Accident Board understand the pilot's decision, the following information was gathered and used to assist the Board's analysis and assessment of this accident. This information focuses on the frequency of blown tire RTO's as well as the training requirements.

RTO Accident/Incident Information

In 1977 a Federal Aviation Administration report³ covering 171 RTO's from 1964 to 1975 concluded that 87 percent had resulted from some failure or malfunction of tires, wheels, or brakes - 74 percent from tires alone. The data revealed that engine failures have not been the dominant causal factor for some time. The Accident Board collected data on RTO accidents and incidents since 1975, when the FAA study ended, to determine if these trends continued. Sixty-one accident/incident records covering January 1976 to September 1985 were identified from National Transportation Safety Board, FAA, British Civil Aviation Authority, and NASA Aviation Safety Reporting System sources. The dominant cause, accounting for 34 percent of the documented cases, was tire/wheel failure. The second most dominant cause, accounting for 23 percent, was engine failure or malfunction. A variety of factors contributed to the remaining 43 percent of the cases. Hence the trend appears to be continuing that engine failures are not the primary cause of aircraft rejected-takeoff accidents/incidents.

Additional information from the Douglas Aircraft Company on a limited number of DC-10 tire-related accidents/incidents indicates that aircraft damage and injury rates are substantially higher if a pilot rejects rather than continues takeoff when faced with tire malfunction at speeds near the calculated decision speed V_1 for the aircraft gross weight, atmospheric conditions, and field elevation.

Pilot Training for Rejected Takeoffs

Statistics indicate that RTO's in response to tire problems are four times more likely to result in an accident or incident than those in response to engine problems. However, in general, RTO training is predicated on an engine failure before reaching V_1 . At the present time, there is no requirement to familiarize pilots with other anomalies such as blown tires that could demand an RTO. In fact, appendix E (Flight Training Requirements) of 14 CFR 121

³Jet Transport Rejected Takeoffs, Final Report, February 1977, Flight Standards Service, Federal Aviation Administration.

states only that air carrier flightcrews must receive takeoff training with a simulated failure of the most critical engine during initial, transition, and upgraded training. This may be accomplished in a visual simulator and does not address RTO training for other reasons.

A survey, as of October 1985, of 16 air carrier flight training simulator facilities indicated that there were 76 simulators in operation that met FAA Phase II or Phase III requirements. These simulators can present failed-tire models with varying degrees of realism. Discussions with training personnel from some of the major air carriers did indicate that pilots are exposed to simulated failed-tire aircraft operations only during transition training from one type of aircraft to another and not during regular currency training. In addition, training personnel stated that procedures for RTO's have been standardized. These procedures are general and do not address specific actions, cautions, or hazards (i.e., directional control, brake failure, rim failure, antiskid anomalies, etc.) associated with RTO's after blown tires. The consensus of the procedures is that once a decision to abort has been made the following steps should be taken:

- (1) Set throttles to idle and simultaneously depress brake pedals fully.
- (2) Maintain directional control.
- (3) Extend spoilers.
- (4) Reverse thrust.
- (5) Put forward pressure (as required) on control column.
- (6) Maintain maximum braking until aircraft stops.

The air carriers' training philosophy is that the RTO procedure does not change to meet different emergency situations. The rationale is that having one procedure for all situations makes it easier to train flightcrews and may significantly reduce flightcrew reaction time to an emergency.

Since statistics indicate that most RTO's result from tire failures and that simulators exist that can model failed tires with varying degrees of realism, it follows that realistic simulator training should be required. The simulator model should be programmed with characteristics to simulate the effects of braking with a blown tire or tires, braking with part of the truck rolling on the rims, the interactions of blown tires and antiskid braking, directional control problems, the braking effort required for maximum effectiveness, and the hazards associated with high-speed RTO's on frangible rims.

REJECTED-TAKEOFF ANALYSIS

This section addresses the pilot's decision-making process and the present decision speed criteria.

Decision Making

In general, the pilot's decision-making process requires two kinds of information, current and background, and this information must be integrated and acted on in seconds. Pilots should be aware that the need for an RTO can occur on every takeoff and should anticipate the problems that may trigger one. The RTO is one of the most demanding maneuvers for a flightcrew to

perform, especially if conducted in a heavy aircraft at or near V_1 , as occurred in this accident. These situations may require a pilot to exercise skill and to make instant decisions at the limits of his/her knowledge and training. Since it is impossible to predict, for instance, a possible tire failure on a heavy, high-speed takeoff, knowledge about various types of situations, when properly applied, can alleviate the need to rely entirely on skill. Obviously in any situation the more background information a pilot has, the faster and more accurate the decision-making process can be.

The most critical element of the accident was the pilot's response to the first tire failures, which occurred just before the aircraft reached V_1 . At the failure moment the pilot had two options: to continue the takeoff or to reject it. The option to continue the takeoff was a viable possibility, since actual runway length was 2,800 feet longer than balanced-field length and all engines were operating normally. In fact, statistics have shown that aircraft that experience blown tires on takeoff, continue the takeoff, and land after decreasing the aircraft gross weight have incurred much less damage than those involved in RTO's. Furthermore the same statistics show there have been no injuries involved in those instances where the takeoff was continued, but there have been fatalities and severe injuries in RTO accidents. In this accident, if the aircraft had taken off successfully, it would have averted a high-speed, heavyweight RTO. However, continuing the takeoff would have involved other factors and pilot decisions in order to maneuver and configure the aircraft to successfully terminate the flight. One cannot say conclusively that continuing the takeoff would have been a better option, only that statistics indicate that the potential for a successful outcome could have been greater.

In this accident, once the pilot made the decision to reject the takeoff, he had two options: (1) maximum deceleration to stop the aircraft as soon as possible, or (2) less than maximum deceleration extending the rollout. The pilot did react promptly to the tire failures and in accordance with the aircraft flight manual's RTO procedures, with the exception of braking. The pilot stated that he intended to use light braking because of the runway length, directional control problems, and his concern with failure of additional tires. These factors along with prior knowledge and experience influenced the pilot's decision not to immediately stop the aircraft, but to let it gradually decelerate. The accepted industry procedure dictates that once an abort decision has been made, maximum braking should be applied immediately for the most efficient deceleration, and it should be held until the aircraft stops while also maintaining directional control. The reasons for this procedure include the following:

- (1) Possible puncture of wing fuel tanks is minimized.
- (2) Wheel braking is most effective while tires are on the wheel rims.
- (3) The risk of additional failure, including brakeline rupture, fuselage puncture, or rim failure, is minimized.
- (4) Onboard personnel can evacuate sooner.
- (5) Aircraft are built and certified to endure brake fires.

In light of the various options that were available in this accident, it is obvious that a fresh look should be given to RTO training and procedures. All pilots should be made aware of accident/incident statistics with particular emphasis on failed-tire RTO's. The necessity for maximum deceleration in

response to an RTO decision should be emphasized. Further studies should be conducted to evaluate completing the takeoff versus the RTO.

Decision Speed Criteria

Traditionally, the basic RTO guideline has been to reject the takeoff if any problem is recognized before V_1 and to continue the takeoff if a problem is recognized at or after V_1 . Since V_1 speed is the go/no-go decision speed in the event of an engine failure, pilots have come to regard V_1 as the go/no-go decision speed for any recognized anomaly during the takeoff roll regardless of other favorable factors. Some of these factors were present in this accident, that is, all engines were operative and the runway was longer than required for a balanced field. Both of these factors allowed for the option to take off as discussed earlier.

Training of pilots to respond with one procedure, cued solely by V_1 speed, for all RTO situations is based on several principles. First, it may be preferable to keep an aircraft with a problem on the ground rather than to take it into the air. Second, there is the innate difficulty of evaluating anomalies and deciding on alternative actions while accelerating at high speed. Third, it is a well-documented training principle that training for a single response to any emergency strengthens the automatic, uniform, expeditious response of the entire flightcrew in a unified action. These reasons are understandable but given the statistics and the finding that more RTO's are caused by tire failures than engine failures, the RTO criterion should be reviewed. Perhaps the decision to reject takeoff should be based on an increasing level of criticality as the aircraft approaches V_1 . One consideration could be that when takeoff speeds are between 20 knots below V_1 and V_1 , only an engine failure could cause the initiation of an RTO. Tire failures and other less serious anomalies would not automatically prompt an RTO. This would address a situation where tire problems manifest themselves just before or at V_1 , compromising the aircraft's capability to stop within the remaining available runway. If the takeoff would be continued, the damaged tire system would neither be subjected to the full weight (without some aerodynamic lifting) of an aircraft loaded for takeoff nor to the stress of a high-speed, maximum-braking-effort RTO. It may be that the only high-speed tire failure that would require an RTO would be one that had caused major engine degradation. This accident is a good example of where better decision speed criteria and more background information regarding RTO's would have been valuable to the pilots to enhance their knowledge and decision-making capability. In this accident, it is conceivable that this could have altered the pilot's decision, allowing for a more favorable outcome.

LESSON LEARNED

This accident had a unique element that is rarely found in rejected-takeoff accidents. That is, the runway was 2,800 feet longer than the calculated balanced-field length. This element allowed the crew to select one of three options at the instant the first two tires failed:

- (1) Allow the aircraft to roll out with little or no braking.
- (2) Maximum brake the aircraft to a stop.
- (3) Continue the takeoff.

It is rare in RTO accidents that the option to allow the aircraft to roll out with little or no braking is available. Most operations involving this type of aircraft are conducted on runways where the balanced-field length is nearly the same as the actual field length. It is somewhat obvious from the analysis of this accident that if a heavy aircraft is allowed to roll at high speeds on frangible rims, there is a high probability that a wing fuel tank will be punctured, a running fuel fire will occur, and the aircraft will be destroyed.

The second option to maximum brake the aircraft to a stop once an RTO is initiated regardless of runway length is the preferred airline procedure. This minimizes the wing fuel tank puncture possibility by slowing down the wheel rotation as quickly as possible. It is recognized that there are other factors involved in this procedure that must be considered; however, the chance for more favorable RTO results is relatively good.

The third option of continuing the takeoff has associated risks that have to be considered. However, in this accident, all engines were operative and there was sufficient runway to continue the takeoff. Continuing the takeoff could have resulted in a lightweight landing with crash/fire/rescue equipment standing by. Statistics do indicate that this option has a good success rate.

It appears clear from the analysis of this accident that the industry as a whole needs to address RTO's with respect to blown tires. Pilots must be informed of the hazards and risks associated with blown-tire RTO's. They should receive realistic simulator training with emphasis on failed-tire RTO problems. This is necessary to provide pilots with a better situation awareness, which can enhance their decision-making process and make them better risk managers.

Given that statistics show that engine failures are no longer the predominant cause for RTO's, action should be taken to change the antiquated RTO decision speed V_1 criterion, since it is based solely on engine failure.

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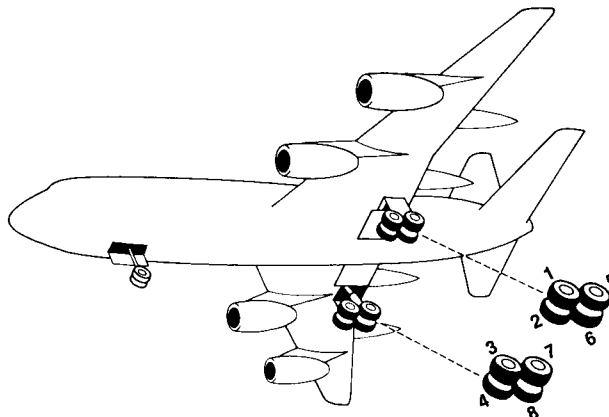


Figure 1. - Positions of tire and wheel assemblies on CV-990 main landing gear.

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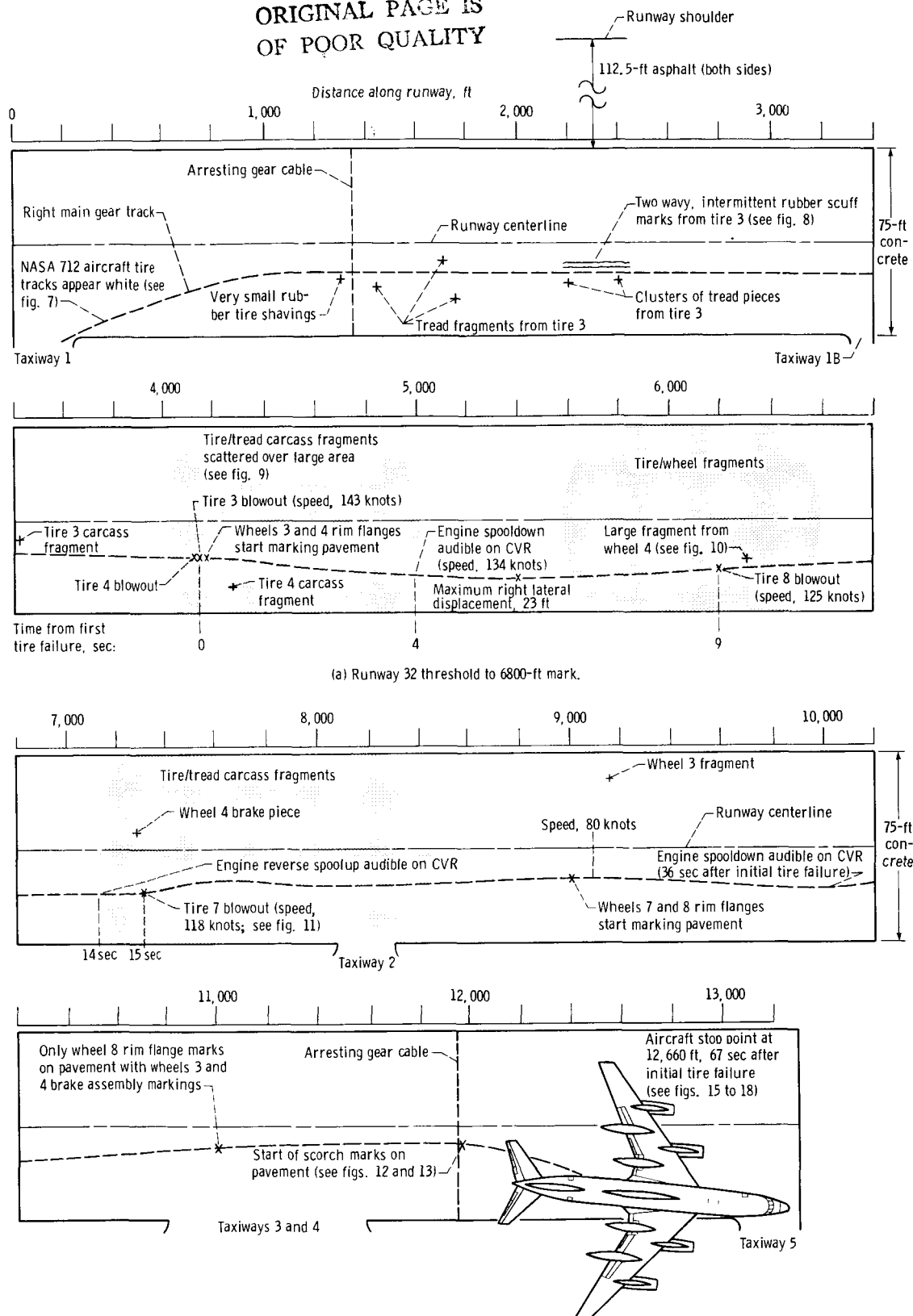
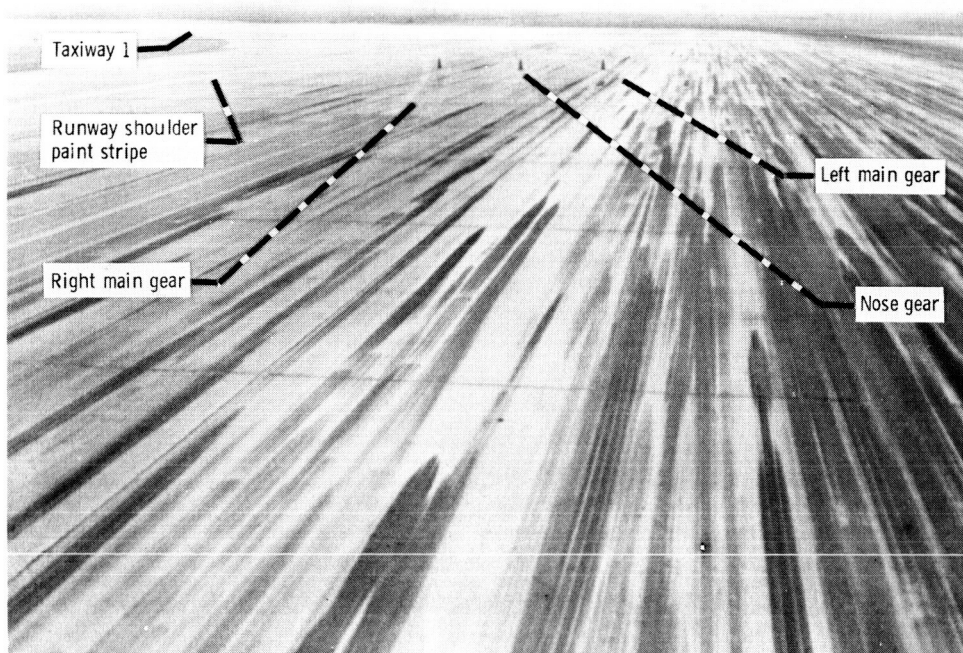
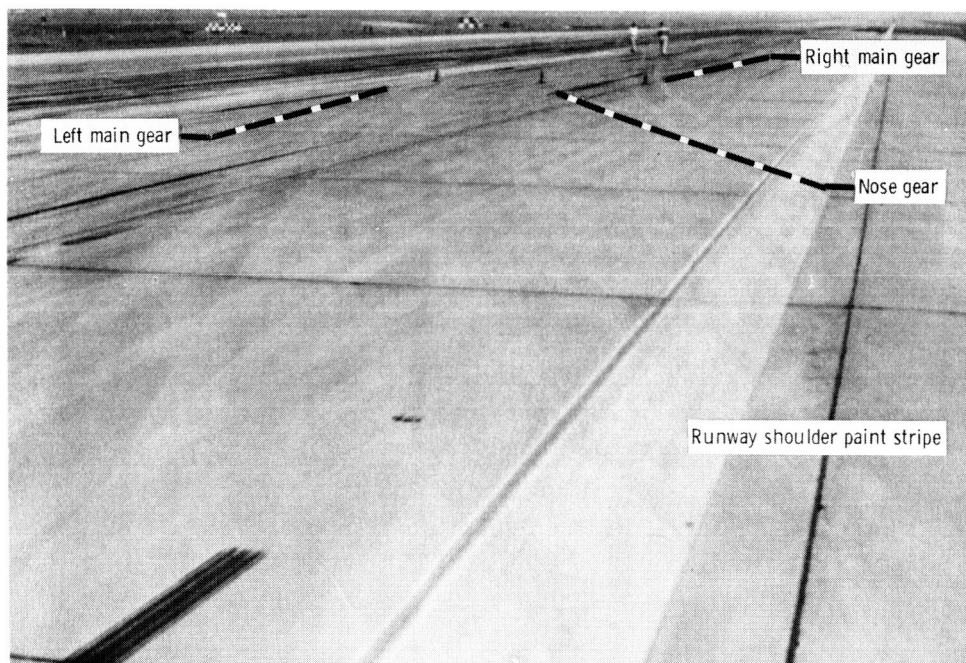


Figure 2. - Reconstruction of NASA 712 accident. Total runway width, 300 ft with 75-ft concrete surface in center and 112.5-ft asphalt on both sides.

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(a) On runway 32 looking back toward taxiway 1.



(b) Near runway shoulder at taxiway 1 looking toward runway 32.

Figure 3. - Suspected white tire scrub marks produced during turn onto runway 32 at taxiway 1.

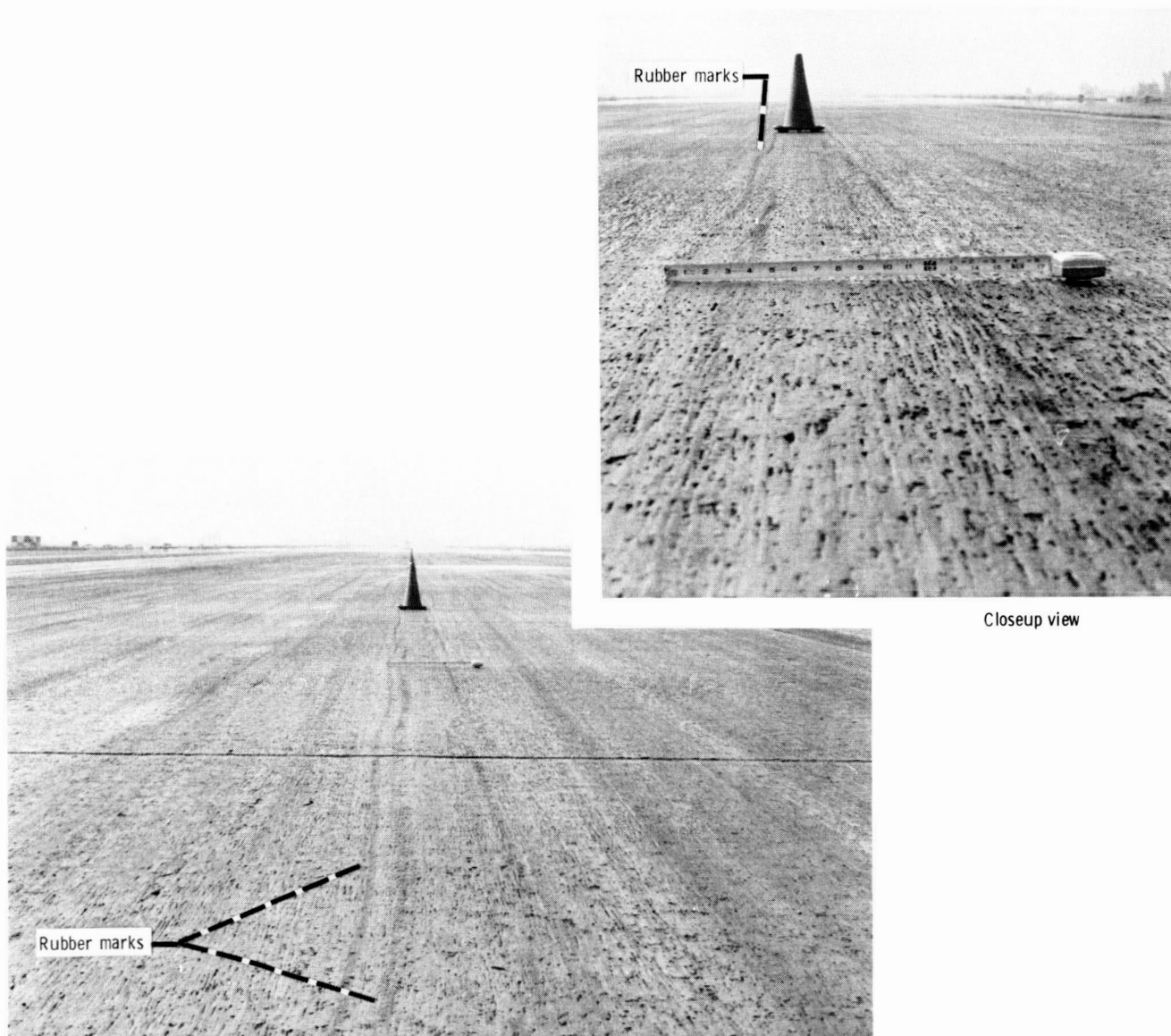
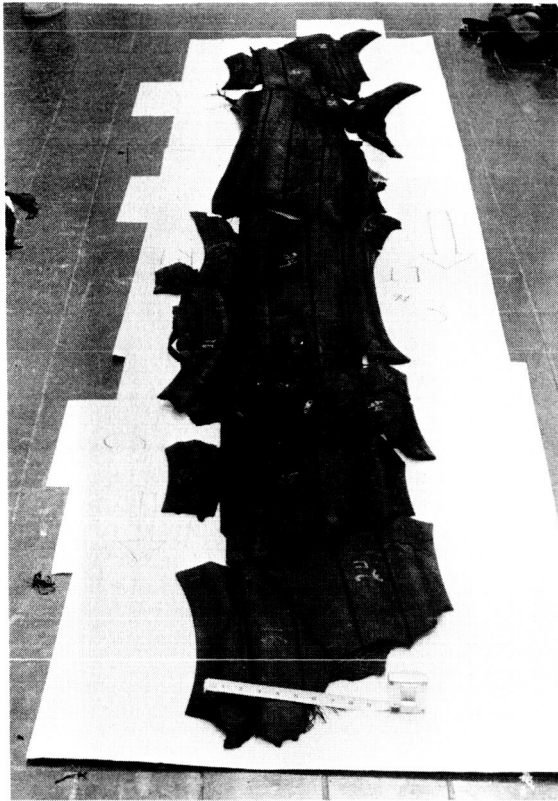
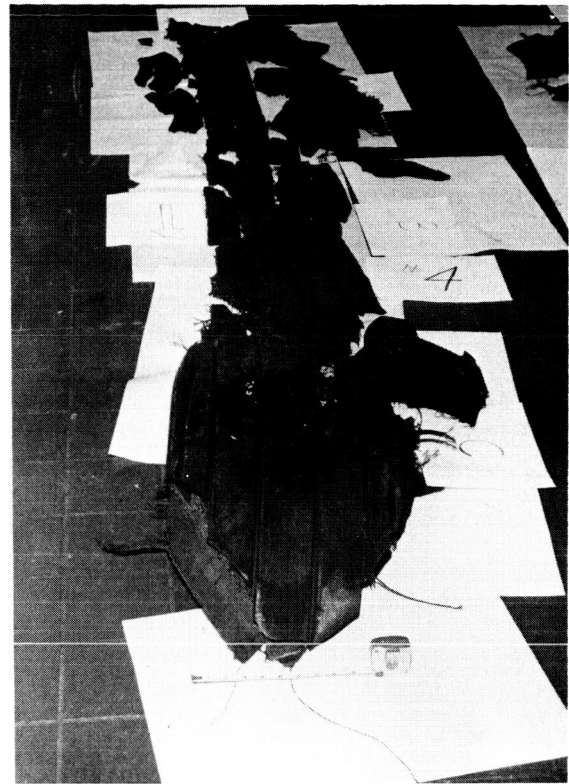


Figure 4. - Tire 3 rubber marks found on surface 2, 200 ft from threshold of runway 32.

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(a) Tire 3 - left front.



(b) Tire 4 - right front.



(c) Tire 7 - left rear.



(d) Tire 8 - right rear.

Figure 5. - Assembled fragments of right main gear tires from NASA 712, found on runway 32 at March Air Force Base, California.

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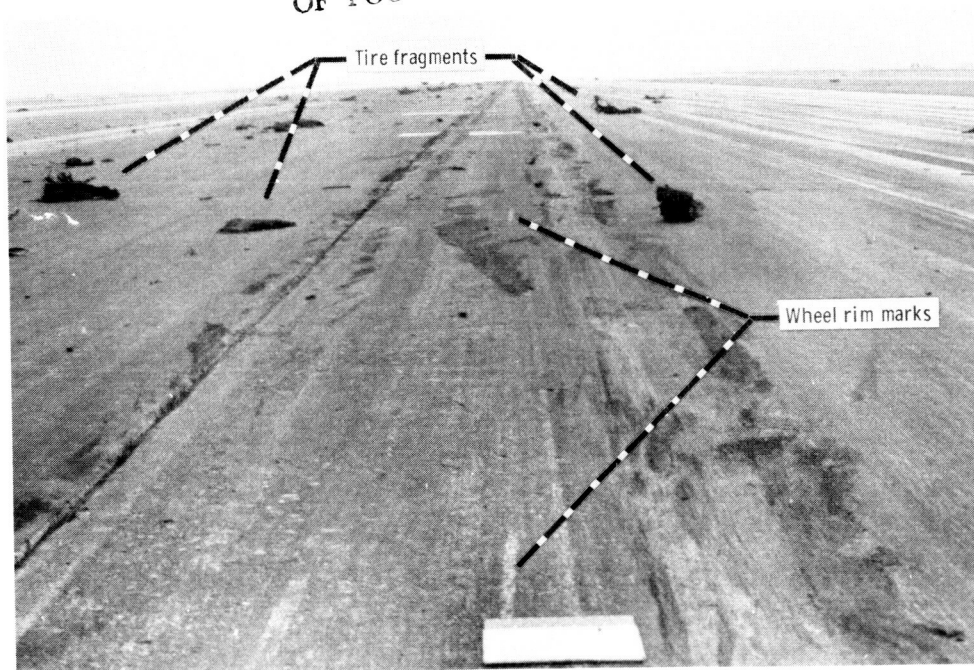


Figure 6. - Wheel flange rim marks and debris from tires 3 and 4 at approximately 4,188 ft from runway 32 threshold.

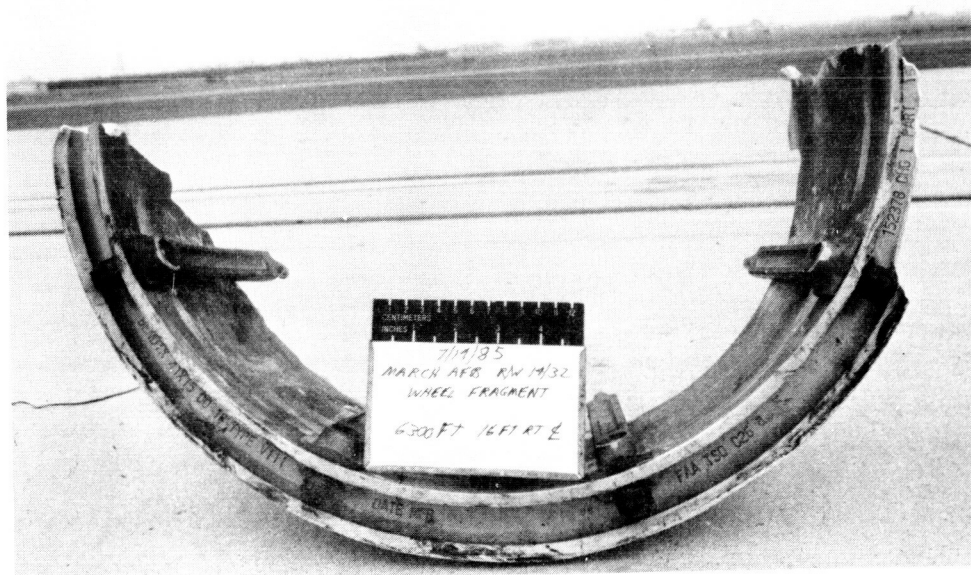


Figure 7. - Fragment of wheel 4 found 6,300 ft from runway 32 threshold.

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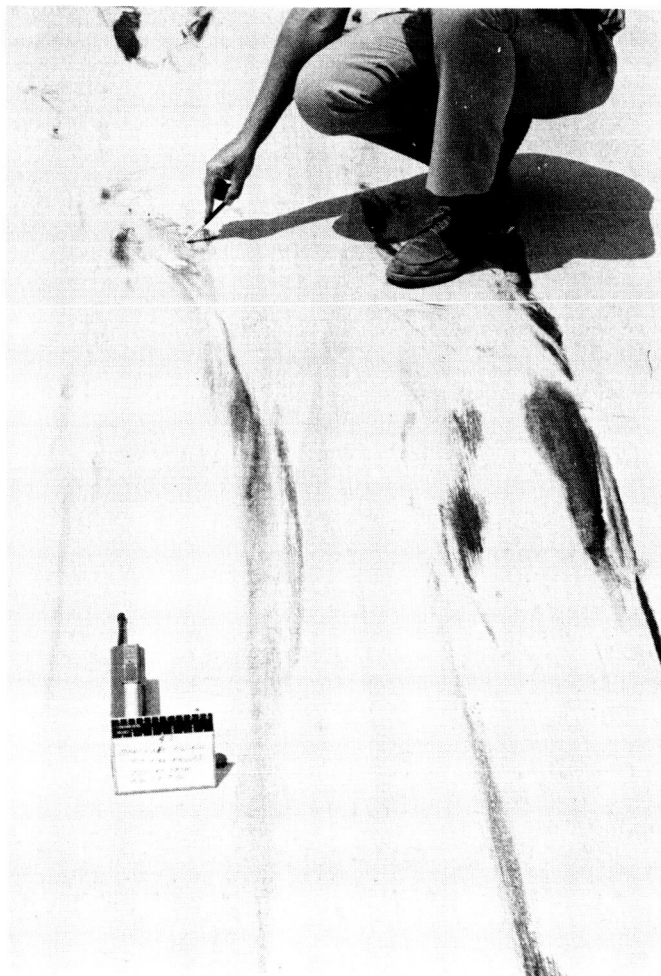
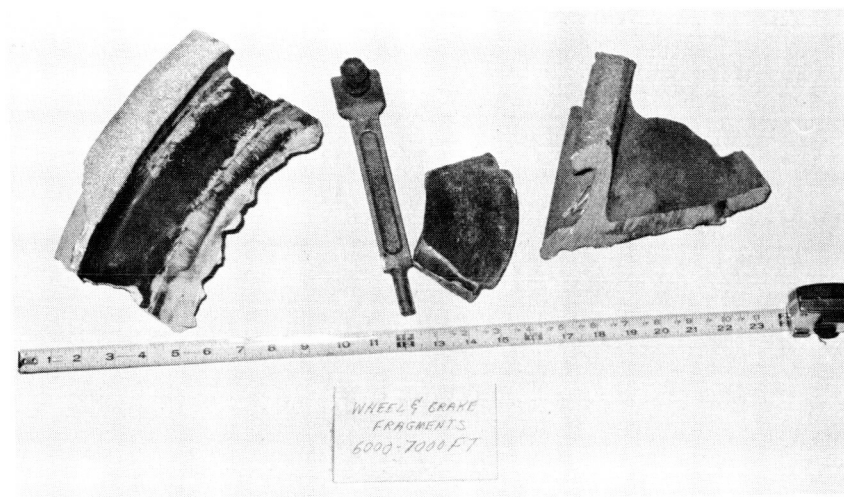
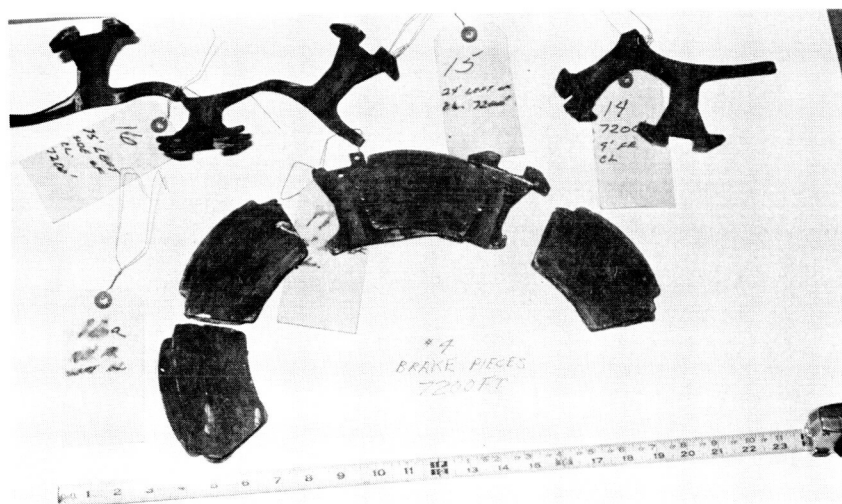


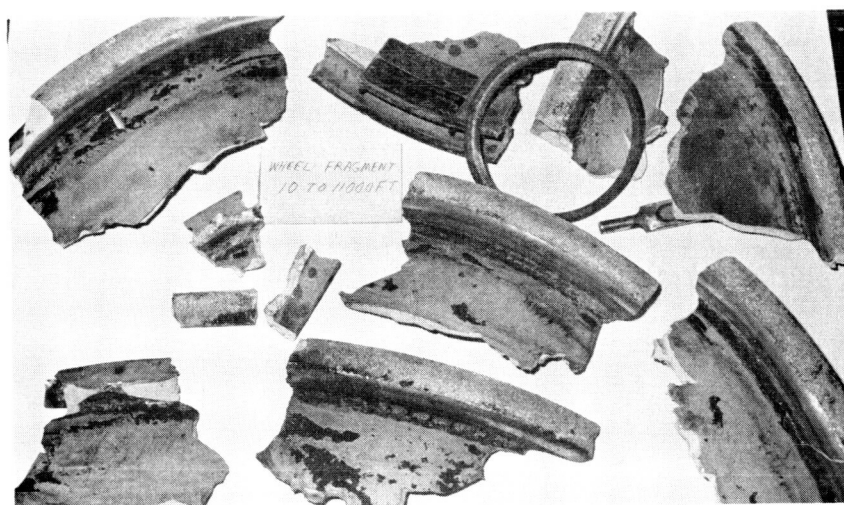
Figure 8. - Runway surface rubber marks from blowout of tire 7.



(a) Found between 6,000 and 7,000 ft down runway 32.



(b) Found nearly 7,200 ft down runway 32.



(c) Found between 10,000 and 11,000 ft down runway 32.

Figure 9. - Some additional fragments of right main gear wheel/brake assembly found at various locations on runway.



Figure 10. - Runway surface scorch marks and tire rubber debris from right main gear at about 11,950 ft down runway 32.

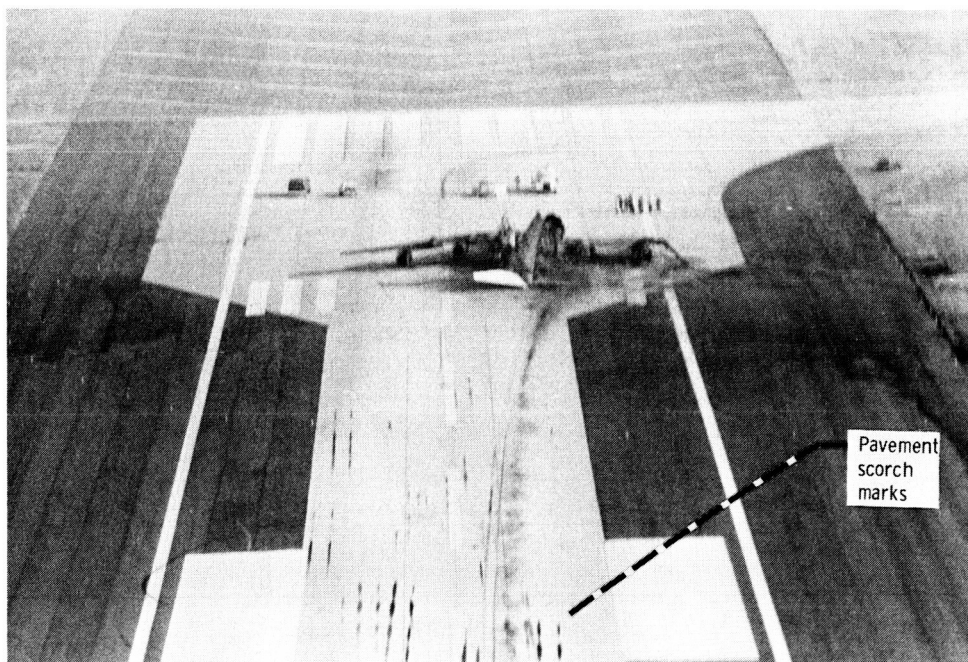


Figure 11. - Aerial view of fire-damaged NASA 712 at stop point, 12,660 ft down runway 32.

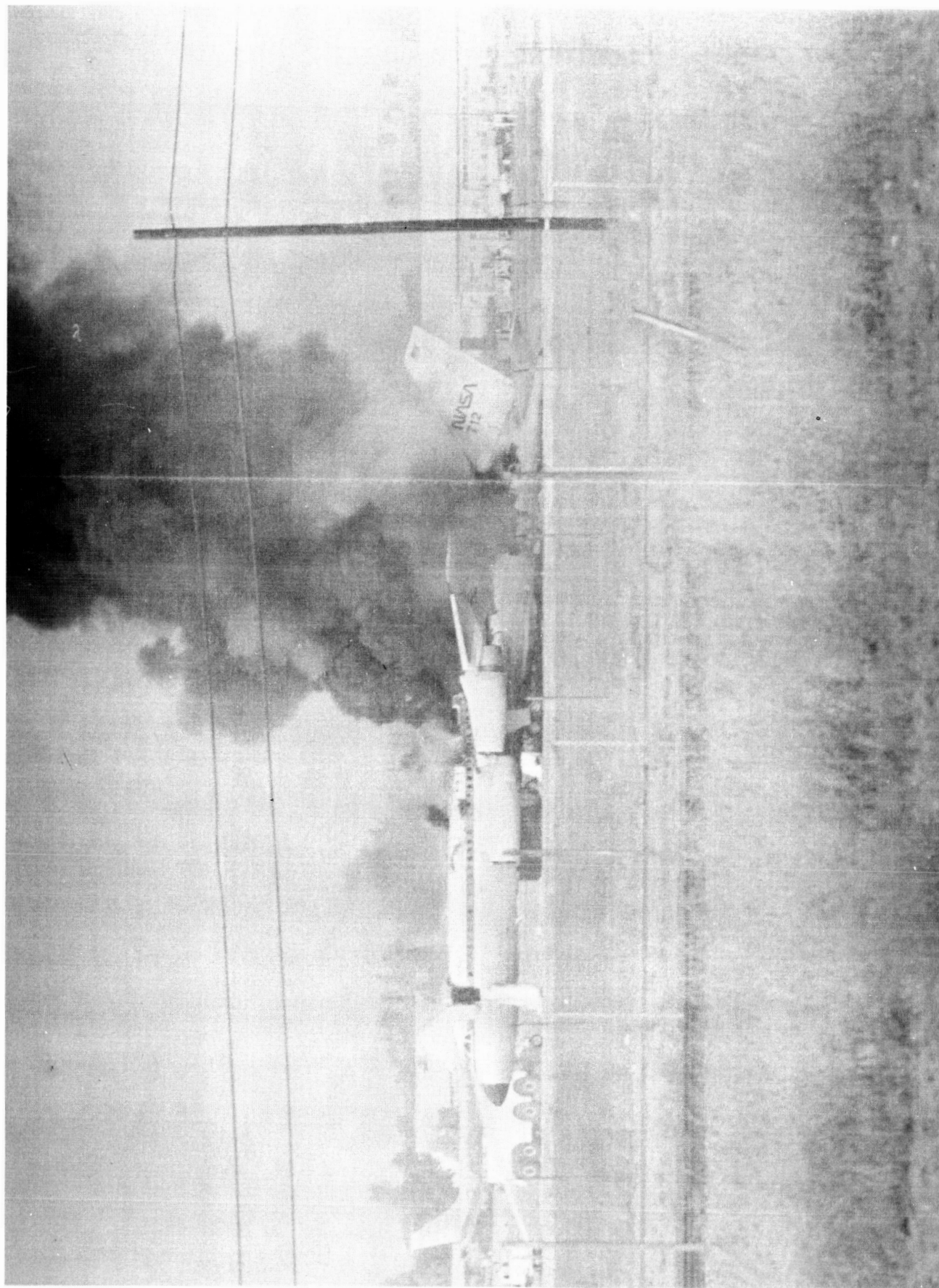


Figure 12. - NASA 712 on fire at end of runway 32.

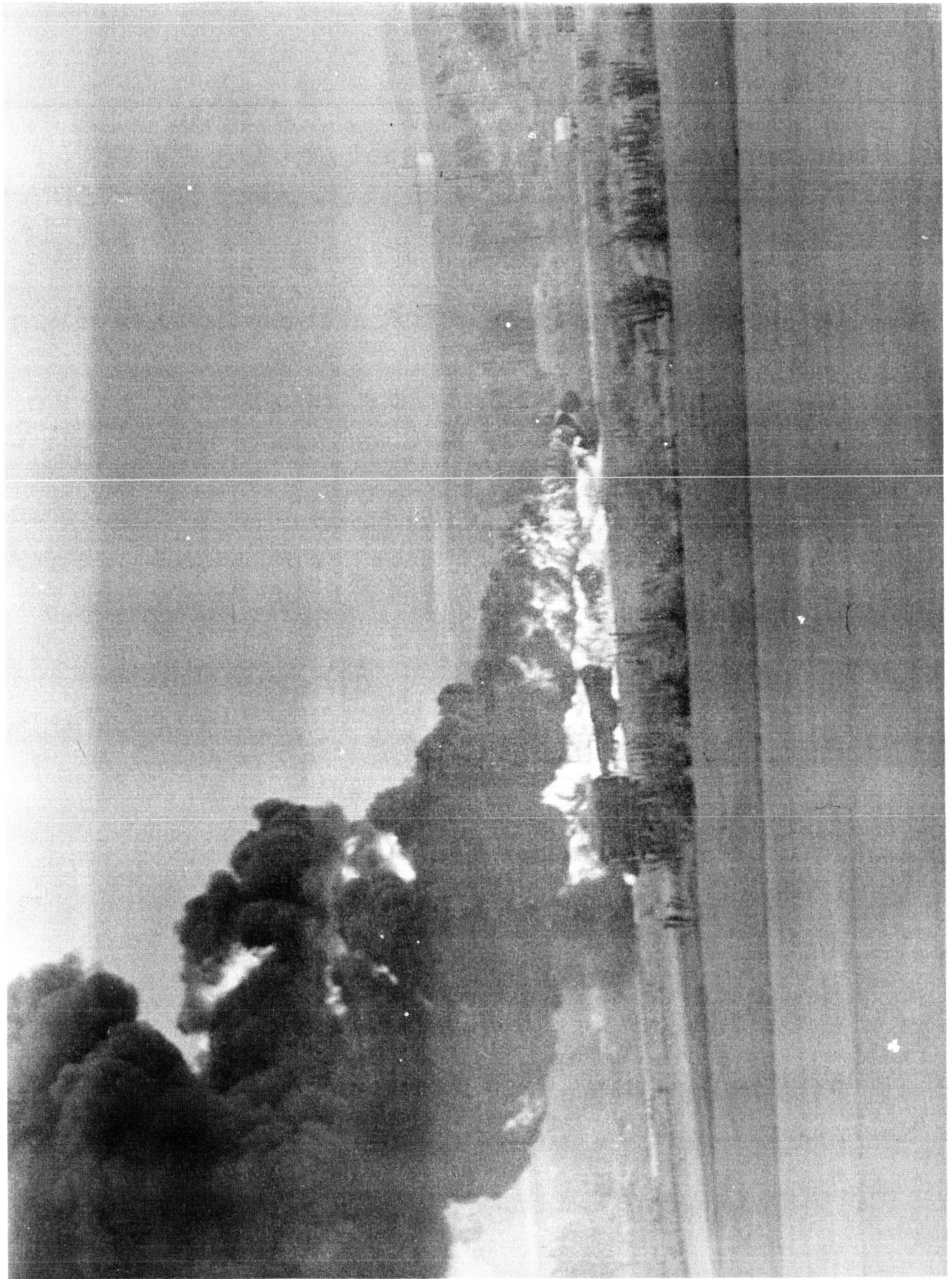


Figure 13. - NASA 712 engulfed in flames.

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Figure 14. - Aerial view of fire-damaged NASA 712 taken at front of wreckage.

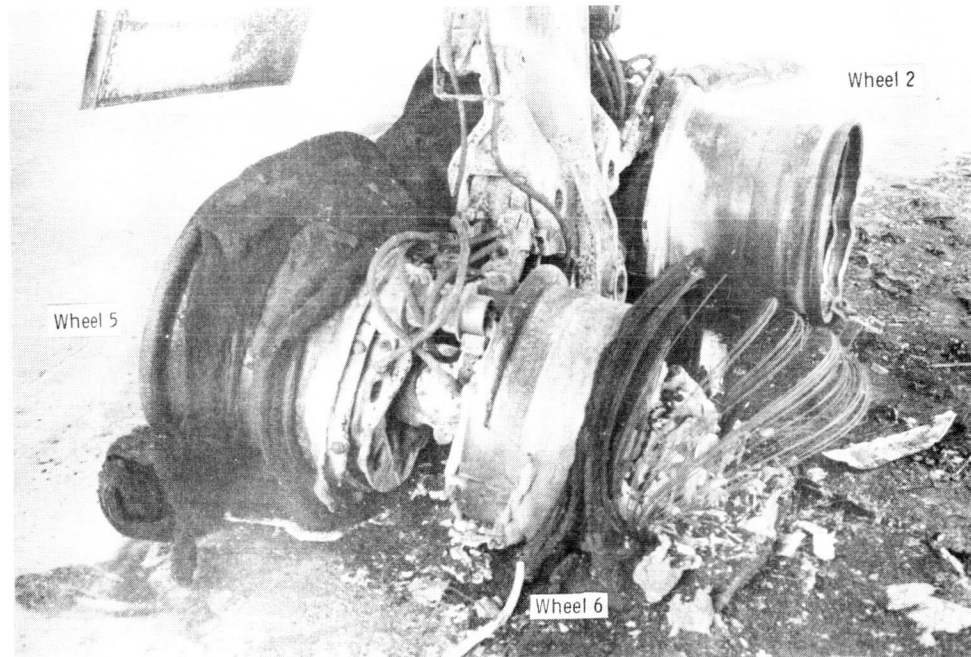


Figure 15. - Closeup view of left main gear wheels.

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Figure 16. - Closeup view of right main gear wheels after fire.

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16. Abstract This paper analyzes a NASA Convair 990 (CV-990) accident with emphasis on rejected-takeoff (RTO) decision making, training, procedures, and accident sta- tistics. The NASA Aircraft Accident Investigation Board was somewhat per- plexed that an aircraft could be destroyed as a result of blown tires during the takeoff roll. To provide a better understanding of tire failure RTO's, the Board obtained accident reports, Federal Aviation Administration (FAA) studies, and other pertinent information related to the elements of this acci- dent. This material enhanced the analysis process and convinced the Accident Board that high-speed RTO's in transport aircraft should be given more empha- sis during pilot training. Pilots should be made aware of various RTO situa- tions and statistics with emphasis on failed-tire RTO's. This background information could enhance the split-second decision-making process that is required prior to initiating an RTO.					
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